Bridging language acquisition and processing via the integrated systems hypothesis: Evidence from self-paced reading of newly-learned words within sentential contexts

Laura M. Morett (University of Alabama), Sarah S. Hughes-Berheim (University of Alabama), John F. Shelley-Tremblay (University of South Alabama)

Introduction. The integrated systems hypothesis posits that gesture and speech mutually and obligatorily interact, affecting language processing [1-2]. Despite the absence of gesture at recall, the presence of semantically-congruent (matching) iconic gesture during word learning enhances subsequent memory for newly-learned words, whereas the presence of semantically-incongruent (mismatching) iconic gesture during word learning hinders subsequent memory for newly-learned words [3], indicating that this hypothesis extends to language representation. At present, however, it is unclear whether semantic congruency of gesture and definitions presented during word learning (e.g., *kroosk—to sweep* [definition], *to drink* [gesture]) affects subsequent processing of newly-learned words within sentential contexts (e.g., He took the cup to *kroosk*). Moreover, it is unclear how gesture is integrated with orthography, which is processed sequentially with gesture in the visual modality. This work fills these lacunae.

Methods. Via a succession of interleaved word learning and self-paced reading (SPR) blocks, native English speakers (*n*=32) learned 96 pseudowords (English phonotactics; controlled for phonological neighborhood density) in sets of 4 and then read corresponding sets of 4 English critical sentences, each ending with a pseudoword, as quickly as possible. In each word learning trial, participants were presented with a pseudoword as text, then a video of an iconic gesture either matching or mismatching the pseudoword's definition (verified via ratings from a separate sample), and then the psudoword's English definition, which they were instructed to remember, as text (presented sequentially with gesture to avoid splitting visual attention between gestures and text; Fig. 1A). In each SPR trial, participants pushed a button to read the context sentence wholesale and the critical sentence word-by-word, ending with the pseudoword (sentence pairs normed to elicit English definitions and gesture meanings; Fig. 1B). Both the semantic congruency of gestures that pseudowords were learned with as well as the semantic congruency of definitions that pseudowords were learned with were manipulated relative to critical sentences to examine how they affect pseudoword processing within this context. Word learning and SPR trials were counterbalanced in congruency and order within their respective blocks.

Results. Prior to analysis, pseudoword SPR latencies ≥3 *SD* beyond cell means (15.54%) were trimmed. Remaining latencies were modeled via linear mixed-effect regression using the maximal random effect structures justified. These analyses revealed that gesture-definition match at learning did not affect pseudoword processing within critical sentences. However, definition-sentence and (to a lesser extent) gesture-sentence semantic congruency (*B*=5.33, *t*=2.03, *p*=.048; *B*=-5.43, *t*=-1.92, *p*=.06) affected pseudoword processing within critical sentences, although these effects were non-interactive. Tukey-corrected pairwise comparisons revealed that SPR latencies were higher for pseudowords with definitions incongruent and gestures congruent with critical sentences than for pseudowords with definitions congruent and gestures incongruent with critical sentences (*p* =.02; see Fig. 2). No other comparisons reached significance.

Discussion. The results demonstrate that pseudowords learned with mismatching iconic gestures are processed less efficiently within sentential contexts with which their definitions are semantically-incongruent and their gestures are semantically-congruent than vice versa for sentential contexts. Moreover, the results demonstrate that pseudowords learned with matching iconic gestures are processed with similar efficiency regardless of whether their definitions and gestures are semantically-congruent or -incongruent with sentential contexts. Both of these findings contradict the prediction of the integrated systems hypothesis that semantic (in)congruency of gestures and definitions should affect processing of newly-learned words similarly, suggesting that it may fail to bridge language acquisition and processing within sentential contexts.

References. [1] Kelly, Ozyurek, & Maris (2010). *Psych. Sci.* Kelly, Creigh, & Bartolotti (2010). *J Cog. Neuro.* [3] Kelly, McDevitt, & Esch (2009). *Lang. & Cog. Processes.*

Figure 1. (A) Word learning trial with iconic gesture mismatching definition of pseudoword. Pseudoword and definition duration: 2000 ms; gesture duration: ~2000 ms; ISI duration: 1000 ms. (B) SPR trial featuring pseudoword learned with semantically-incongruent definition and semantically-congruent gesture. All stimuli presented until button pressed to proceed.

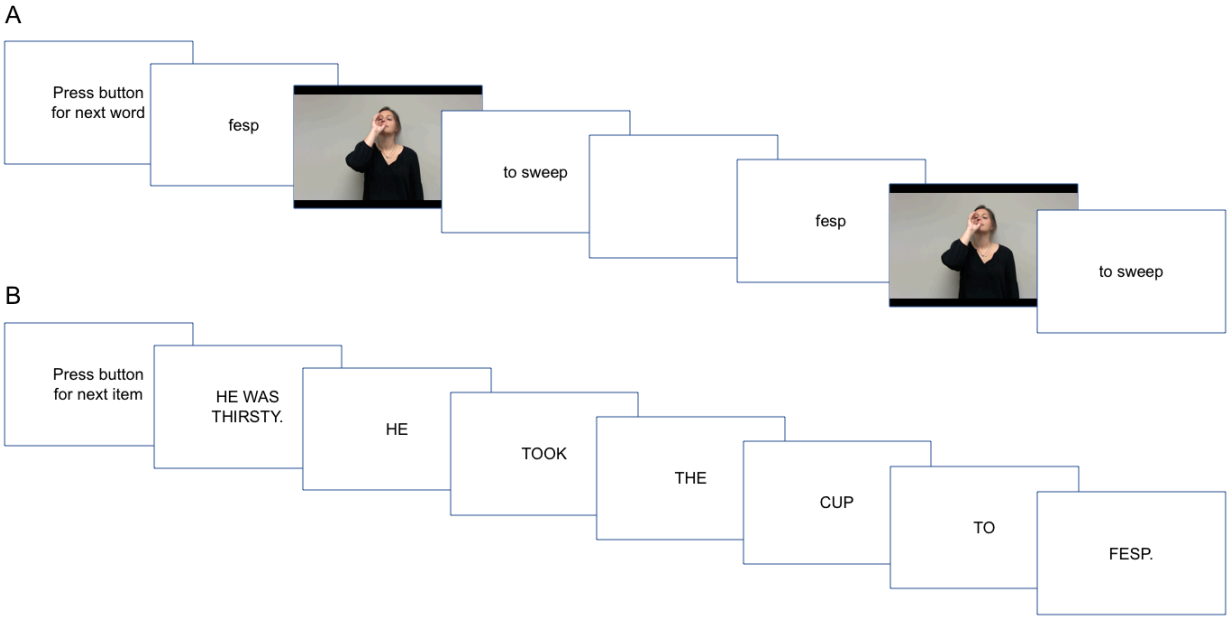

Figure 2. Pseudoword SPR latency by gesture-definition match at learning and definition-sentence and gesture-sentence semantic congruency. White dots and values represent cell means. $^{*}p < .05$, definition-sentence congruency; $^{\dagger}p < .10$, gesture-sentence congruency